

We can know more in double-slit experiment

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We show that we can know more than the orthodox view does, as one example, we make a new analysis about double-slit experiment, and demonstrate that we can measure the objective state of the particles passing through the two slits while not destroying the interference pattern, the measurement method is to use protective measurement.

Double-slit experiment has been widely discussed, and nearly all textbooks about quantum mechanics demonstrated the weirdness of quantum world using it as one example, as Feynman said, it contains all mysteries of quantum mechanics, but have we disclosed these mysteries and understood the weirdness in double-slit experiment? as we think, the answer is definitely No.

When discussing double-slit experiment, the most notorious question is which slit the particle passes through in each experiment, it is just this problem that touches our sore spots in understanding quantum mechanics, according to the widely-accepted orthodox view, this question is actually meaningless, let's see how it gets this bizarre answer, it assumes that only an measurement can give an answer to the above question, then detectors need to be put near both slits to measure which slit the particle passes through, but when this is done the interference pattern will disappear, thus the orthodox view asserts that the above question is meaningless since we can not measure which slit the particle passes through while not destroying the interference pattern.

In fact, the above question is indeed meaningless, and at it happens the orthodox answer is right, but its reason is by no means right, the genuine reason is that if the particle passes through only one slit in each experiment, the interference pattern will not be formed at all*, thus it is obviously wrong to ask which slit the particle passes through in each experiment, it does not pass through a single slit at all!

On the other hand, we can still ask the following meaningful question, namely how the particle passes through the two slits to form the interference pattern? now as to this question, the deadly flaw of the orthodox view is clearly unveiled, what is its answer? as we know, its answer will be there does not exist any objective motion picture of the particle, the question is still meaningless, but how can it get this conclusion? it can't! and no one can.

Since we have known that the particle does not pass through a single slit in each experiment, the direct position measurement near both slits is obviously useless for finding the objective motion state of the particle passing through the two slits, and it will also destroy the objective motion state of the particle, then the operational basis of the orthodox view disappears, it also ruins, thus the orthodox demonstrations can't compel us to reject the objective motion picture of the particle†, it only requires that the motion picture of classical continuous motion should be rejected, this is undoubtedly right, since the motion of microscopic particle will be not classical continuous motion at all, it will be one kind of completely different motion.

Once the objective motion picture of the particle can't be essentially rejected, we can first have a look at it using the logical microscope, since the particle does not pass through a single slit in each experiment, it must pass through both slits during passing through the two slits, it has no other choices! this kind of bizarre motion is not impossible since it will take a period of time for the particle to pass through the slits, no matter how short this time interval is, so far as it is not zero, the particle can pass through both slits during this finite time interval, what it must do is just discontinuously move, nobody can prevent it from moving in such a way! in fact, as we have demonstrated [4], this is just the natural motion of particle.

*Here we assume the only existence of particle, thus Bohm's hidden-variable theory [3] is not considered.

†Why we can't detect which slit the particle passes through when not destroying the interference pattern is not because there does not exist any objective motion picture of the particle, but because the particle does not pass through a single slit at all.

On the other hand, in order to find and confirm the objective motion picture of the particle passing through the two slits, which will be very different from classical continuous motion, we still need a new kind of measurement, which will be very different from the position measurement, fortunately it has been found several year ago [1,2], its name is protective measurement, since we know the state of the particle beforehand in double-slit experiment, we can protectively measure the objective motion state of the particle when it passes through the two slits, while the state of the particle will not be destroyed after such protective measurement, and the interference pattern will not be destroyed either, thus by use of this kind of measurement we can find the objective motion picture of the particle passing through the two slits while not destroying the interference pattern, and the measurement results will reveal that the particle indeed passes through both slits as we see using the logical microscope.

Now, the above analysis has strictly demonstrated that we can know more than the orthodox view does in double-slit experiment, namely we know that the particle passes through both slits to form the interference pattern, while the orthodox view never knows this.

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 - [3] D.Bohm, Phys.Rev. **85**,166-193. (1952)
 - [4] Gao Shan, quant-ph/.